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Research determined whether students who used a teaching machine made greater achievement gains than students who spent an equal amount of time studying by conventional methods, whether the teaching machine compensated for ability differences in students, and whether the teaching machine compensated for poor study habits.

Subjects consisted of 103 university students. They were split into a control and an experimental group. Pretests to determine initial knowledge and final tests to determine knowledge at the end of the experiment were administered. Study habits were measured by the Brown-Holzman Survey of Study Habits, and verbal intelligence was measured by the verbal score from the School and College Ability Test. Both groups were initially comparable on all measures. Seven chapters from the textbook were programed for use in the teaching machine, and were covered at the rate of one chapter a week.

Results indicated that the teaching machine was a valuable study aid. Students of both high and low ability performed better when using the machine; lower ability students profited more.

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THE TEACHING MACHINE AS A STUDY AID

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The pros and cons of the teaching machine are currently being loudly debated in education. On one hand we have the commercial interests proclaiming the teaching machine as a solution to all of education's problems. On the other hand we find many school teachers, whose anxieties lead them to discount the machine as being nothing more than a new form of workbook.

Perhaps the main promise that many psychologists see in the teaching machine is that the machine, to a degree, employs certain learning principles which are generally agreed to be important by learning theorists. Most of you are familiar with these principles but for those who are not, I shall mention a few of them and briefly discuss how the teaching machine applies them.

First, a learner should be active rather than a passive listener or viewer.

Although the type of participation varies with the type of machine, all teaching machines require frequent responses on the part of the learner. In the Foringer machine used in our research at Utah State University, the student must write his response to every stimulus item presented by the machine.

Reinforcement or repetition under conditions in which correct responses are rewarded, is important to learning. This is another learning principle which the teaching machine applies. All teaching machines provide the learner with some form of reinforcement. Immediate reinforcement provides the learner with immediate knowledge of the correctness of his response and thus reduce the liklihood of learning an incorrect response.

Still another feature of the teaching machine that is important in learning is its provisions for individual differences. The machine usually presents the material to be learned in small and easily understood steps and as the speed of response and number of repetitions is controlled by the learner, the machine automatically adapts to different levels of ability.

I will now review briefly the research carried out at the Bureau of Educational Research, Utah State University during the past year. In this study, teaching machines were used as a learning aid for college students taking general psychology. The major objectives of the research aimed at answering the following questions:

(1) Do students who study with the aid of the teaching machine make significantly greater achievement gains than students who spend an equal amount of time in studying without the use of the machine?

(2) Does the teaching machine tend to compensate for ability differences in students? That is, does the performance of the low ability student come up as compared with the high ability student when teaching machines are used?

(3) Does the teaching machine tend to compensate for poor study habits? That is, does the student with poor study habits tend to make similar achievement gains to the student with good study habits when both use the teaching machine as a study aid?

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The subjects consisted of 103 U.S.U. students taken from two sections of General Psychology. The subjects were randomly split into a control and an experimental group within each section to insure that an equal number from each section was assigned to each group.

Seven chapters from Introduction to Psychology by Clifford T. Morgan were programmed for use in the teaching machine and were covered at the rate of one each week. These chapters are referred to as the experimental chapters. The nine remaining chapters covered throughout the study are referred to as control chapters because they did not receive any special attention by either the control or experimental groups.

The initial reading of each experimental chapter by both groups was done the first day of each week during the regular class period. No one was excused from participation and if absent was required to make up the period the following day.

All subjects were required to attend two fifty-minute study sessions each week. During this time they would review the material read the previous Monday. The experimental subjects reported for the study sessions, checked out a program on the material scheduled for the week, and proceeded immediately to an available machine where they would begin to work. The control subjects reported at their scheduled times to a classroom adjacent to the teaching machine room. Upon reporting, the control subject immediately began reviewing, in his own way, the material read the previous Monday. These sessions were monitored to insure that subjects were studying the appropriate material.

Pre-tests designed to determine the initial knowledge of each subject concerning the course content, and final tests to determine the knowledge of each subject at the end of the experiment were administered. The difference between the final and the pre-test scores for each subject represented achievement gain.

Two standardized measures were also used, Brown-Holtzman Survey of Study Habits and Attitudes which provides a quantitative measure of a student's study habits and related attitudes, and the verbal score from the School and College Ability Test which is essentially a measure of verbal intelligence.

Results

The principal results of this study are concerned with comparisons between achievement gains of the experimental and control groups, achievement gains made by students with high and low verbal ability, and achievement gains made by students with good and poor study habits. Analysis of the pre-test scores and other preliminary data indicated that the experimental and control groups were initially comparable on all measures. No significant differences existed on pre-test scores between the groups. A comparison of the numbers of hours spent in outside study by the members of the experimental and control groups also show the same results. Let us now examine the performance of these initially comparable groups under the experimental and control conditions.

The experimental group, studying with the aid of the machine, made significantly greater gains on the experimental chapters than did the control group who studied without using machines.* To further add to the consistency of this finding, the experimental group made significantly greater gains on those chapters for which they used the machine than they did on the control chapters for which they did not use the

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* All differences reported were significant beyond the 1% level unless indicated otherwise.

machine. In addition, the control and experimental groups showed no significant difference between their performance on the control chapters, in which neither group used the machine. It was also found that the control group did not register significantly different gains on the experimental chapters than they did on the control chapters. On this basis, the evidence appears definite that significantly greater gains are consistently associated with use of the machine.

In the next phase of the analysis, comparisons were made between the upper and lower 50% of each group in verbal ability. Mastery of psychology, to a great extent, is dependent upon verbal ability. Therefore, it would be expected that those subjects more capable in verbal ability would do better than those not so capable. This is supported by the fact that the upper 50% of the control group did significantly better than the lower 50% on both sets of chapters.

In comparing the performance of the upper 50% of the experimental group with the lower 50% of the experimental group, it was found that the upper 50% made significantly greater gains, but only at the 5% level as compared with a difference beyond the 1% level for the control group. Though this is but tentative, (the small difference between performance of high and low ability subjects in the experimental group suggests that the use of the machine may tend to compensate somewhat for low verbal ability.)

An additional comparison was made between the performance of the lower 50% of the experimental group in verbal ability and the upper 50% of the control group, on the experimental chapters. The results showed no significant difference in their achievement gains. From previous results it can be concluded that the machine will benefit nearly all students, but from this latter comparison it is interesting to note that those in the lower 50% in verbal ability did as well when using the machine as did those in the upper 50% in verbal ability when not using the machine.

The purpose of the next phase of the study was to determine the relationship between study habits and the teaching machine use. On all chapters, the control subjects in the upper 50% on study habits made significantly greater achievement gains than did control subjects in the lower 50%. This finding is not unusual, for it would be expected that the subjects with better study habits would make greater achievement gains, other things being equal. However, it is important to note that the upper 50% of the experimental group on study habits did not make significantly greater gains than did the lower 50% when using the machines. (This indicates that while the machine helps all groups make greater gains generally, the machine seems to compensate to a degree for poor study habits.) The result is that the student with poorer study habits, when using the machine, makes a comparable achievement gain to the student with better study habits. You will recall that this was not the case with students not using the machine, where significant differences emerged in favor of those with better study habits.

A further comparison was made which further illustrates the value of the machine in bringing about greater achievement gains. It was found that subjects in the lower 50% on study habits when using the machine, made slightly greater achievement gains (though not significant) than did the upper 50% of the group not using the machine.

In summary, the results of the study leave little doubt that the teaching machine is a valuable study aid when its use is compared with achievement made using conventional study methods. This study presents only limited evidence to indicate that the teaching machine compensates to any significant degree for ability differences. Students of both high and low ability do better when using the machine than they do when not using it, with lower ability students profiting slightly more from

use of the machine than higher ability students. Performance of students with poor and good study habits indicates that in this area the machine does much to compensate for poor study habits.

In view of the short duration of this study it is likely that some of the differences reported are attributable to the Hawthorne Effect.

Summary of the Teaching Machine as a Study Aid

The Problem:

(1) Do students who study with the aid of a teaching machine make significantly greater achievement gains than students who spend an equal amount of time in studying without the use of the machine?

(2) Does the teaching machine tend to compensate for ability differences in students? That is, does the performance of the low ability student come up as compared with the high ability student when teaching machines are used?

(3) Does the teaching machine tend to compensate for poor study habits? That is, does the student with poor study habits tend to make similar acheivement gains to the student with good study habits when both use the teaching machine as a study aid?

Subjects:

Experimental group -- 51 college students in General Psychology.
Control group -- 52 college students in General Psychology.

Measures:

(1) Psychology achievement tests.
(2) Brown-Holtzman Survey of Study Habits and Attitudes.
(3) School and College Ability Test, verbal scale.

Results:

Major results are summarized in the following tables:

Table 1. Significance of the difference between means resulting from various comparisons of the top and bottom 50 percent in verbal ability

Group	Chapters	Mean Scores: Pre-test Top 50%	Pre-test Btm 50%	Final test Top 50%	Final test Btm 50%	F_x	F_y	$F_{y.x}$
Experimental	Experimental	27.69	22.92	49.23	39.44	8.79**	13.02**	6.25*
Control	Experimental	26.96	23.05	42.46	3[illegible]	7.72**	31.77**	20.70**
Experimental	Control	28.58	25.08	40.81	38.44	7.95**	.84	
Control	Control	27.85	24.65	41.10	31.66	8.00**	20.29**	14.60**
Top 50%-Con Btm 50%-Exp	Experimental	26.96	22.92	42.46	39.44	11.17**	1.23	

* Significant at .05 level of probability.
** Significant at .01 level of probability.

Table 2. Significance of the difference between means resulting from various comparisons of the top and bottom 50 percent in study habits and attitudes.

Group	Chapters	Mean Scores Pre-test Top 50%	Pre-test Btm 50%	Final test Top 50%	Final test Btm 50%	F_x	F_y	$F_{x.y}$
Experimental	Experimental	25.72	25.00	45.28	43.62	.31	.40	
Control	Experimental	26.58	23.54	41.62	32.38	4.67*	19.20**	13.45**
Experimental	Control	27.88	25.88	42.08	37.31	2.33	3.60	
Control	Control	27.12	25.38	40.27	32.35	2.11	11.95**	9.56**
Top 50%-Con Btm 50%-Exp	Experimental	26.58	25.00	41.62	43.62	1.23	.69	

* Significant at .05 level of probability.
** Significant at .01 level of probability.

Table 3. Pre-test and post-test comparisons between experimental and control groups

Variable	Exp. Group Mean	Control Group Mean	F
1. Pretest Score on Experimental Chapters	25.35	25.06	N.S.*
2. Pre-test Score on Control Chapters	26.86	25.25	N.S.
3. Brown-Holtzman SSHA, pre-test	28.76	28.73	N.S.
4. SCAT Verbal, pre-test	31.22	30.85	N.S.
5. Hours reported spent in outside study			
Experimental Chapt.	12.53	11.10	N.S.
Control Chapters	14.75	16.13	N.S.
6. Absences from class lectures	2.92	2.92	N.S.
7. Post-test, experimental chapters	44.43	37.00	17.16**
8. Post-test, control chapters	39.63	36.31	N.S.

* Not significant.
** Significant at the .01 level.

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